

XRF PERFORMANCE CHARACTERISTICS SHEET

Advanced Detectors; LeadStar

EFFECTIVE DATE: October 7, 1996

EDITION NO.: 1

MANUFACTURER AND MODEL:

Make: *Advanced Detectors, Inc.*
Model: *LeadStar*
Source: *Co⁵⁷*
Note: This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above.

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from the EPA/HUD evaluation using archived building components. Testing was conducted on approximately 150 test locations. All of the test locations were tested twice in 1995, in June and in August. Two instruments (both installed with software version 4.05) were used in the June 1995 testing and one instrument (with software version 4.08) was used in the August 1995 testing. All three instruments had a June 1995 source at 15 mCi initial strength. The same test locations were tested twice again in 1996, in August and in September. One instrument (with software version 4.30) was used in the August 1996 testing, with a July 1996 source at 15 mCi initial strength. One instrument (also with software version 4.30) was used in the September 1996 testing, with an August 1996 source at 15 mCi initial strength. Each instrument had a distinct serial number.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when operating the instrument under the same conditions as the evaluation testing and using the procedures described in Chapter 7 of the HUD Guidelines. Operating parameters include:

- Manufacturer-recommended warm-up and quality control procedures
- Use the Multifamily Decision Flowchart for determining the presence of lead on a component type in multifamily housing
- Take readings on three locations per component for single-family housing and one location per component for multifamily housing
- Calibration checks are taken using the red (1.02 mg/cm²) NIST Standard Reference Material (SRM No. 2579) paint film
- Readings for determining the substrate correction values are taken on bare substrate covered with red (1.02 mg/cm²) NIST SRM paint film
- Lead-based paint is defined as paint with lead equal to or in excess of 1.0 mg/cm².

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XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to determine the operating condition of the XRF instrument. For this instrument, calibration check readings should be taken in *Fixed Mode*. If the observed calibration check average minus 1.02 mg/cm² is greater than the positive (plus) calibration check tolerance value, or less than the negative (minus) calibration check tolerance value, then the instructions provided by the manufacturer should be followed in order to bring the instrument back into control before any more XRF testing is done. This calibration check is estimated to produce an incorrect result (that is, a finding that the instrument is out of calibration) very infrequently - once out of every 200 times this procedure is followed.

Use the following calibration check tolerance values for *Fixed Mode* readings for those instruments with software versions 4.1 to 4.30. (This guidance may be used for software versions higher than 4.30 if the higher software version incorporates the same signal processing and data treatment algorithms that are in software version 4.30).

minus value = -0.2 mg/cm²
plus value = +0.0 mg/cm²

Use the following calibration check tolerance values for *Fixed Mode* readings for those instruments with software versions earlier than version 4.1.

minus value = -0.2 mg/cm²
plus value = +0.1 mg/cm²

(Operators may choose to use limits in the manufacturer's operations manual for this calibration check. The rate of an incorrect result if the limits in the manufacturer's operations manual are followed may be different from the rate of an incorrect result stated here.)

FOR XRF RESULTS BELOW 4.0 mg/cm², SUBSTRATE CORRECTION RECOMMENDED FOR:

For those instruments with software versions 4.1 to 4.30. (This guidance may be used for software versions higher than 4.30 if the higher software version incorporates the same signal processing and data treatment algorithms that are in software version 4.30).

none

For those instruments with software versions earlier than version 4.1

Metal

SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

For those instruments with software versions 4.1 to 4.30.

Brick, Concrete, Drywall, Metal, Plaster, and Wood

For those instruments with software versions earlier than version 4.1.

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Brick, Concrete, Drywall, Plaster, and Wood

SUBSTRATE CORRECTION VALUE COMPUTATION:

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the red (1.02 mg/cm²) NIST SRM paint film for substrate correction is provided below.

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over red NIST SRM (1.02 mg/cm²) paint films at test locations that had been scraped clean of their paint covering. Compute the correction values as follows:

- Using the same XRF instrument, take three readings on a bare substrate area covered with the red NIST SRM (1.02 mg/cm²) paint film. Repeat this procedure by taking three more readings on a second bare substrate area of the same substrate covered with the red NIST SRM (1.02 mg/cm²) paint film.
- Compute the correction value for each substrate type by computing the average of all six readings as shown below.

For each substrate type recommended for substrate correction:

$$\left. \begin{array}{l} \text{Correction} \\ \text{Value} \end{array} \right\} = \frac{1^{st} + 2^{nd} + 3^{rd} + 4^{th} + 5^{th} + 6^{th} \text{ Reading}}{6} - 1.02 \text{ mg/cm}^2$$

INCONCLUSIVE RANGE OR THRESHOLD:

XRF results are classified using either the threshold or the inconclusive range. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. For computing the XRF result, use all digits that are reported by the instrument. For the threshold, results are classified as positive if they are greater than or equal to the threshold, and negative if they are less than the threshold. There is no inconclusive classification when using the threshold. For the inconclusive range, results are classified as positive if they are greater than or equal to the upper limit of the inconclusive range, and negative if they are less than or equal to the lower limit of the inconclusive range. Thresholds and inconclusive ranges reported here were determined for comparing results to the 1.0 mg/cm² standard. For a listing of laboratories recommended by the EPA National Lead Laboratory Accreditation Program (NLLAP)

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for the analysis of samples to resolve an inconclusive XRF result or additional confirmational analysis, call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

For those instruments with software versions 4.1 to 4.30. (This guidance may be used for software versions higher than 4.30 if the higher software version incorporates the same signal processing and data treatment algorithms that are in software version 4.30).

15-SECOND FIXED MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm ²)	INCONCLUSIVE RANGE (mg/cm ²)
Results not corrected for substrate bias	Brick	None	0.9 to 1.1
	Concrete	None	0.9 to 1.1
	Drywall	None	0.9 to 1.1
	Metal	None	0.9 to 1.2
	Plaster	1.0	None
	Wood	None	0.9 to 1.1

BRIEF MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD in mg/cm ²
Results not corrected for substrate bias	Brick	1.0
	Concrete	1.0
	Drywall	1.0
	Metal	1.0
	Plaster	1.0
	Wood	1.0

For those instruments with software versions earlier than version 4.1.

15-SECOND FIXED MODE READING DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE in mg/cm ²
Results corrected for substrate bias for readings on metal substrates only	Brick	0.9 to 1.3
	Concrete	0.9 to 1.3
	Drywall	0.9 to 1.1
	Metal	0.9 to 1.1
	Plaster	0.9 to 1.1
	Wood	0.9 to 1.1

INSTRUCTIONS FOR EVALUATING XRF TESTING:

Chapter 7 of the HUD Guidelines recommends several options for evaluating XRF testing. Among those options is the following procedure which may be used after XRF testing has been completed. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. If a multifamily housing development is being retested, randomly select two units from within the development from which the ten testing combinations should be randomly selected.

Randomly select ten testing combinations for retesting from each house or from the two selected units.

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Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Compute the average of the original and re-test result for each of the ten testing combinations.

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the overall average of all ten retest XRF results over all ten testing combinations selected for retesting.

Take the difference of the overall average of the ten original XRF results and the overall average of the ten retest XRF results. If the difference is negative, drop the negative sign.

If the difference of the overall averages is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

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TESTING TIMES:

For *Fixed Mode*, the LeadStar instrument tests for a set length of time before a result is obtained and displayed. For *Brief Mode*, the LeadStar instrument tests until a reading is obtained relative to an operator set *Action Level*. The following table provides a summary of testing times for readings taken in *Brief Mode* with an *Action Level* set to 1.0 mg/cm². All times have been scaled relative to an initial source strength of 15 mCi. Note that source strength and factors such as substrate may affect testing times.

Results from testing in August 1996 and September 1996

BRIEF MODE TESTING TIMES* (Seconds)						
SUBSTRATE	ALL DATA			MEDIAN FOR LABORATORY-MEASURED LEAD LEVELS (mg/cm ²)		
	25 th Percentile	Median	75 th Percentile	Pb < 0.25	0.25 ≤ Pb < 1.0	1.0 ≤ Pb
Wood Drywall	7	7	8	7	8	7
Metal	7	7	8	7	8	7
Brick Concrete Plaster	8	8	9	8	8	8
*Testing times are based on readings obtained relative to a 1.0 mg/cm ² <i>Action Level</i> .						

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BIAS AND PRECISION:

Do not use these bias and precision data to correct for substrate bias. These bias and precision data were computed without substrate correction from samples with reported laboratory results less than 4.0 mg/cm² lead. There were 15 test locations taken in *Fixed Mode* with a laboratory reported result equal to or greater than 4.0 mg/cm² lead. The fifteen test locations were each tested four times in *Fixed Mode*, once under software version 4.05, once under software version 4.08, and twice under software version 4.30. Of the 15 test locations tested under software version 4.05, one case resulted in an XRF reading was less than 1.0 mg/cm². Of the 45 test locations tested under software versions 4.08 and 4.30, there were no instances in which an XRF reading was less than 1.0 mg/cm². Each of the fifteen test locations were tested in *Brief Mode* twice, both under software version 4.30. Out of the 30 *Brief Mode* testing cases, there were no instances in which an XRF reading was less than 1.0 mg/cm². The following data are for illustrative purposes only. Actual bias must be determined on-site. Inconclusive ranges provided above already account for bias and precision. Units are in mg/cm².

For those instruments with software versions 4.1 to 4.30.

FIXED MODE READINGS MEASURED AT	SUBSTRATE	BIAS (mg/cm ²)	PRECISION [*] (mg/cm ²)
0.0 mg/cm ²	Brick	0.0	0.1
	Concrete	0.0	0.1
	Drywall	0.0	0.1
	Metal	0.1	0.1
	Plaster	-0.1	0.1
	Wood	0.0	0.1
0.5 mg/cm ²	Brick	0.1	0.2
	Concrete	0.1	0.2
	Drywall	0.0	0.2
	Metal	0.1	0.2
	Plaster	0.0	0.2
	Wood	0.1	0.2
1.0 mg/cm ²	Brick	0.1	0.3
	Concrete	0.1	0.3
	Drywall	0.1	0.3
	Metal	0.2	0.3
	Plaster	0.0	0.3
	Wood	0.1	0.3
2.0 mg/cm ²	Brick	0.2	0.4
	Concrete	0.2	0.4
	Drywall	0.2	0.4
	Metal	0.3	0.4
	Plaster	0.1	0.4
	Wood	0.2	0.4
[*] Precision at 1 standard deviation			

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FIXED MODE READINGS MEASURED AT	SUBSTRATE	BIAS (mg/cm ²)	PRECISION ¹ (mg/cm ²)
0.0 mg/cm ²	Brick	0.1	0.1
	Concrete	0.1	0.1
	Drywall	0.0	0.1
	Metal	0.1	0.1
	Plaster	0.0	0.1
	Wood	0.0	0.1
0.5 mg/cm ²	Brick	0.2	0.2
	Concrete	0.2	0.2
	Drywall	0.1	0.2
	Metal	0.2	0.2
	Plaster	0.1	0.2
	Wood	0.1	0.2
1.0 mg/cm ²	Brick	0.3	0.3
	Concrete	0.3	0.3
	Drywall	0.1	0.3
	Metal	0.2	0.3
	Plaster	0.1	0.3
	Wood	0.1	0.3
2.0 mg/cm ²	Brick	0.4	0.5
	Concrete	0.4	0.5
	Drywall	0.3	0.5
	Metal	0.4	0.5
	Plaster	0.3	0.5
	Wood	0.3	0.5
¹ Precision at 1 standard deviation			

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristics Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7 of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead-Based Paint Abatement and Poisoning Prevention, U.S. Department of Housing and Urban Development, Room B-133, 451 Seventh St, S.W., Washington, DC 20410.